# CHAPTER 33
# Chronic Obstructive Lung Disease

## KEY TEACHING POINTS

- The most accurate physical signs of chronic obstructive lung disease are also infrequent, occurring in fewer than 50% of patients.
- In patients with chronic dyspnea, many findings increase the probability of obstructive lung disease: *early inspiratory* crackles, diminished breath sound score, subxiphoid cardiac impulse, hyperresonance of the chest, accessory muscle use, and pursed lip breathing.
- Two findings decrease the probability of obstructive lung disease: a breath sound score of 16 or more and a forced expiratory time less than 3 seconds.
- In patients with exacerbations of obstructive lung disease, the BAP-65 score, which combines the patient's age and three findings (BUN >25 mg/dL, altered mental status, and pulse rate ≥110 beats/minute), accurately predicts the risk of mechanical ventilation or death.

## I. INTRODUCTION

Although descriptions of emphysema date to autopsy reports from the 1600s, it was Laennec who in 1819 recorded the clinical features associated with the disease, including dyspnea, hyperresonance, faint breath sounds, and wheezes.[1] Over the past 200 years, others have embellished Laennec's description, but the principal bedside findings are the same. Writing in 1892, Osler stated that emphysema could be recognized "at a glance" from its characteristic features, including rounded shoulders; barrel chest; prominent epigastric cardiac impulse; hyperresonant chest; loss of cardiac, liver, and splenic dullness; enfeebled breath sounds; and prolonged expiration.[2]

In the 1920s clinicians began to recognize that these traditional physical signs had shortcomings.[3] In 1927 Cabot wrote that only approximately 5% of patients with emphysema at autopsy were recognized during life and that, of patients diagnosed with emphysema during life, only 25% actually had it at autopsy.[4] Spirometry, invented in 1846 and used in many forms (stethometers, pneumatometers, doppelstethograms) to supplement bedside diagnosis, gained favor because of these deficiencies and eventually became the favored diagnostic tool.[1]

This chapter compares the traditional physical signs with spirometry. As a general rule the most accurate physical signs are also infrequent, occurring in fewer than 50% of affected patients, usually only those with the most severe disease.[5,6] For decades or longer, patients may harbor mild and moderate disease that is hidden from the eyes of the bedside examiner but is detectable by spirometry.

# II. THE FINDINGS

Most of the traditional findings of chronic obstructive pulmonary disease (COPD) result from a hyperinflated chest and the great effort necessary to move air across obstructed airways. Some of these physical signs are discussed in other chapters: asynchronous breathing (Chapter 19); barrel chest, pursed lips breathing, and accessory muscle use (Chapter 28); hyperresonance to percussion (Chapter 29); pulsus paradoxus (Chapter 15); diminished breath sounds and wheezing (Chapter 30), and prolonged forced expiratory times (Chapter 31).

Additional findings are discussed below.

## A. INSPECTION

### 1. INSPIRATORY RECESSION OF SUPRACLAVICULAR FOSSA AND INTERCOSTAL SPACES

Some patients with respiratory distress from obstructive lung disease have recession or indrawing of the soft tissues of the intercostal spaces and supraclavicular fossa. This finding is attributed to excess inspiratory resistance, which introduces a delay between the generation of large negative pleural pressures and subsequent increase in lung volume.[7]

### 2. COSTAL PARADOX (HOOVER SIGN, COSTAL MARGIN PARADOX)

The costal paradox is an abnormal movement of the costal angle, which is the angle formed by both costal margins as they approach the xiphoid process on the anterior body wall. The clinician assesses costal movements by placing his hands on each costal margin and observing how the hands move with respect to each other as the patient breathes. In a normal person, inspiration causes the lateral aspects of the lower ribs to move outward, like the handle of a bucket, and the clinician's hands separate as the costal angle widens. In contrast, in patients with the costal paradox the hyperinflated chest can expand no further and the flattened diaphragm instead pulls the costal margins and the clinician's hands together. An online video of Hoover sign is available.[8*]

### 3. LEANING FORWARD ON ARMS PROPPED UP ON KNEES[9,10]

Many patients with obstructive disease experience prompt relief of their dyspnea if they lean forward, which allows them to generate greater inspiratory force with fewer accessory muscles. This position probably diminishes dyspnea because it compresses the abdominal contents and pushes the diaphragm upward, helping to restore the normal domed appearance necessary for efficient and strong inspiratory movements.

## B. PALPATION: LARYNGEAL HEIGHT AND DESCENT

According to traditional teachings the distance between the thyroid cartilage and suprasternal notch (*laryngeal height* or *tracheal length*) is shorter in obstructive lung disease than in normal persons because the clavicles and sternum are positioned abnormally high (see the section on "Barrel Chest" in Chapter 28). Patients with severe obstruction also have more forceful diaphragmatic contractions that, although ineffective in moving large amounts of air, may pull

* www.cmaj.ca/cgi/content/full/cmaj.092092/DC1.

the trachea abnormally downward during inspiration (*laryngeal descent*, *tracheal descent*, or *tracheal tug*).

# III. CLINICAL SIGNIFICANCE

## A. INDIVIDUAL FINDINGS

EBM Box 33.1 shows that several findings increase the probability of obstructive lung disease: *early inspiratory* crackles (likelihood ratio [LR] = 14.6), absence of cardiac dullness (LR = 11.8), breath sound score of 9 or less (LR = 10.2), subxiphoid cardiac impulse (LR = 7.4), hyperresonance of the chest (LR = 7.3), forced expiratory time of 9 seconds or less (LR = 4.1), reduced breath sounds (i.e., overall impression without use of the breath sound score, LR = 3.5), use of the scalene or sternocleidomastoid muscles during inspiration (LR = 3.3), and pursed lip breathing (LR = 2.7). Among patients with known obstructive lung disease, *early inspiratory* crackles imply that the disease is severe (i.e., forced expiratory volume in 1 second [FEV1]/forced vital capacity [FVC] <0.44; LR = 20.8).[19] The simple presence of crackles without reference to their timing is diagnostically unhelpful (LR not significant).[6,14]

Only two findings significantly decrease the probability of obstructive disease: a breath sound score of 16 or more (LR = 0.1) and a forced expiratory time less than 3 seconds (LR = 0.2).

The evidence supporting the chest wall signs of obstructive lung disease is meager and conflicting (see also the section on "Barrel Chest" in Chapter 28). One study showed that indrawing of the soft tissues correlated with severity of obstruction,[24] whereas another did not.[25] In two studies, Hoover sign (LR = 4.2; see EBM Box 33.1) and maximum laryngeal height of 4 cm or less (LR = 3.6) increased the probability of obstructive lung disease, but in two other studies these signs correlated poorly with measures of obstruction.[24,26] A thoracic ratio of 0.9 or more increases probability of obstructive disease slightly (LR = 2). The degree of laryngeal descent is unhelpful (LR not significant).

The chest excursion of patients with obstructive disease (mean: 3 to 4 cm, measured as change in circumference between maximum inspiration and maximum expiration, using a tape measure at the level of the fourth intercostal space) is less than that of normal persons (mean: 6 to 7 cm), but the lower limit observed in normal persons (2 to 3 cm) makes it impossible to draw significant conclusions in a single person.[26,27]

## B. COMBINED FINDINGS

Of the many successful diagnostic schemes that combine findings,[15,21] one of the simplest asks only three questions: (1) Has the patient smoked more than 70 pack-years? (2) Has the patient been previously diagnosed with chronic bronchitis or emphysema? (3) Are breath sounds diminished in intensity? Answering "yes" to two or three of these questions is a compelling argument for obstructive disease (LR = 25.7; see EBM Box 33.1).

Although using the self-reported history of emphysema as a diagnostic indicator seems to be a circular argument, the specificity of this question is only 74%, which means that 26% of patients *without* obstructive lung disease actually remembered such a history. This question is more discriminatory than other symptoms (i.e., dyspnea, sputum production, age, or use of theophylline, steroids, inhalers, or home oxygen) and many other findings (i.e., hyperresonant chest, absence of cardiac dullness, and wheezes).[5]

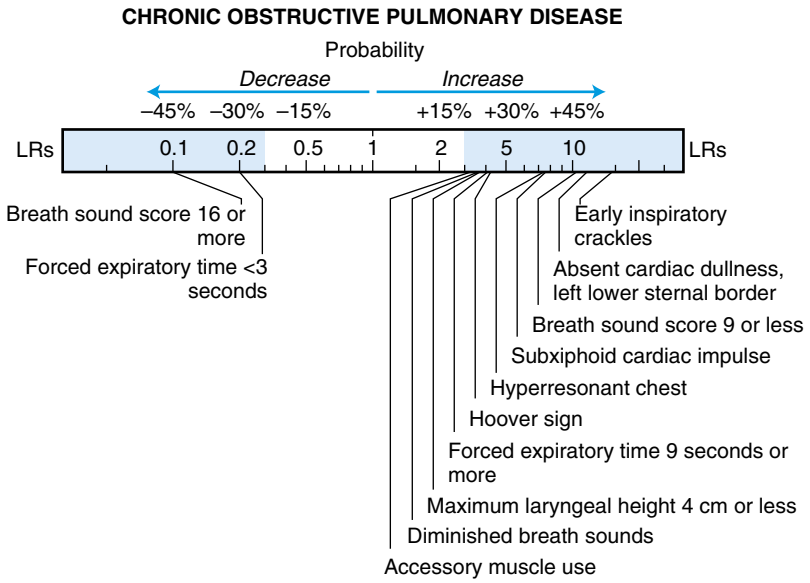
## EBM BOX 33.1
## *Chronic Obstructive Pulmonary Disease**

| *Finding (Reference)*† | *Sensitivity (%)* | *Specificity (%)* | Likelihood Ratio‡ if Finding Is | |
|---|---|---|---|---|
| | | | *Present* | *Absent* |
| Barrel chest[11] | 65 | 58 | 1.5 | 0.6 |
| AP/L chest diameter ratio ≥0.9[11] | 31 | 84 | 2.0 | NS |
| Pursed lip breathing[11] | 58 | 78 | 2.7 | 0.5 |
| Scalene/sternocleido-mastoid muscle use[11] | 39 | 88 | **3.3** | 0.7 |
| Maximum laryngeal height ≤4 cm[12] | 36 | 90 | **3.6** | 0.7 |
| Laryngeal descent >3 cm[12] | 17 | 80 | NS | NS |
| Hoover sign[13] | 58 | 86 | **4.2** | 0.5 |
| ***Palpation*** | | | | |
| Subxiphoid cardiac impulse[5,6] | 4-27 | 97-99 | **7.4** | NS |
| ***Percussion*** | | | | |
| Absent cardiac dullness left lower sternal border[5] | 15 | 99 | **11.8** | NS |
| Hyperresonance of chest[5,14] | 21-33 | 94-98 | **7.3** | 0.8 |
| Diaphragm excursion percussed <2 cm[5] | 13 | 98 | NS | NS |
| ***Auscultation*** | | | | |
| Reduced breath sounds[5,11,13-15] | 29-82 | 63-96 | **3.5** | 0.5 |
| ***Breath Sound Score***[16,17] | | | | |
| ≤9 | 23-46 | 96-97 | **10.2** | — |
| 10 to 12 | 34-63 | — | **3.6** | — |
| 13 to 15 | 11-16 | — | NS | — |
| ≥16 | 3-10 | 33-34 | **0.1** | — |
| Early inspiratory crackles[18,19] | 25-77 | 97-98 | **14.6** | NS |
| Any unforced wheeze[5,6,12-14,20,21] | 13-56 | 86-99 | 2.6 | 0.8 |
| ***Ancillary Tests*** | | | | |
| ***Forced Expiratory Time***[21-23] | | | | |
| ≥9 s | 29-50 | 86-98 | **4.1** | — |
| 3-9 s | 42-54 | — | NS | — |
| <3 s | 8-10 | 26-62 | **0.2** | — |

**EBM BOX 33.1**
*Chronic Obstructive Pulmonary Disease*—cont'd*

| *Finding (Reference)*† | *Sensitivity (%)* | *Specificity (%)* | Likelihood Ratio‡ if Finding Is | |
|---|---|---|---|---|
| | | | *Present* | *Absent* |
| ***Combined Findings*** | | | | |
| Two out of the following three present: (1) smoked 70 pack-years or more; (2) self-reported history of chronic bronchitis or emphysema; (3) diminished breath sounds[5] | 67 | 97 | **25.7** | 0.3 |

**Diagnostic standards:* For *chronic obstructive lung disease,* FEV1/FVC ratio <0.6-0.7 (palpation, percussion, diminished breath sounds, and combined findings), FEV1/FVC <0.7-0.75 (inspection, crackles, wheezes, and forced expiratory time), or FEV1 <40% predicted (breath sound score).
†*Definition of finding:* For *maximal laryngeal height*, distance between the top of the thyroid cartilage and suprasternal notch at the end of expiration; for *laryngeal descent*, difference in laryngeal height between end inspiration and end expiration; for *Hoover sign,* paradoxical indrawing of the lateral rib margin during inspiration, noted when the patient is standing; for *hyperresonance of chest,* upper right anterior chest[5] or undefined location;[14] for *breath sound score*, see Chapter 30; for *forced expiratory time,* see Chapter 31.
‡Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.
*AP/L,* Anteroposterior/lateral; *FEV1,* forced expiratory volume in 1 second; *FVC,* forced vital capacity; *NS,* not significant.Not significant.
Click here to access calculator



**EBM BOX 33.2**

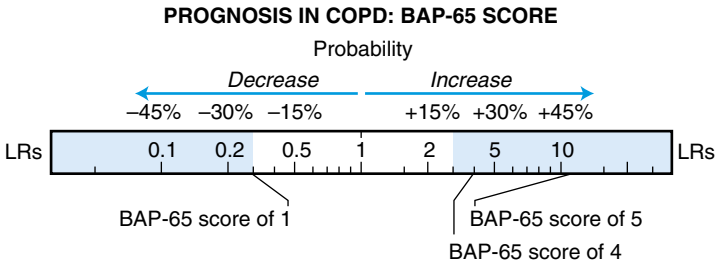
*Prognosis in Chronic Obstructive Pulmonary Disease Exacerbation: The BAP-65 Score*[*28,29]

| BAP-65 Class | Definition | Mechanical Ventilation or Hospital Mortality % | Likelihood Ratio |
|---|---|---|---|
| 1 | 0 BAP present, age ≤65 years | 1.6 | **0.3** |
| 2 | 0 BAP present, age >65 years | 2.3 | 0.4 |
| 3 | 1 BAP present | 7.3 | NS |
| 4 | 2 BAP present | 23.8 | **4.0** |
| 5 | 3 BAP present | 43.8 | **10.4** |

*BAP predictors refers to the total number of the following predictors that are present: (1) Blood urea nitrogen >25 mg/dL, (2) Altered mental status (disoriented or Glasgow coma scale <14), and (3) Pulse ≥110 beats/min.

*BAP,* Blood urea nitrogen, *A*ltered mental status, and *P*ulse; *NS,* not significant.

Click here to access calculator




## C. PROGNOSIS IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE EXACERBATION (*B*LOOD UREA NITROGEN, *A*LTERED MENTAL STATUS, AND *P*ULSE-65 SCORE)

In studies of more than 120,000 patients hospitalized with COPD exacerbation, three clinical findings accurately predicted the risk of mechanical ventilation or hospital mortality (overall risk for these complications was 3% to 11%): (1) *B*lood urea nitrogen of more than 25 mg/dL, (2) *A*ltered mental status, and (3) *P*ulse of 110/minute or higher (the mnemonic "BAP"[†] helps clinicians to recall these findings).[28] Based on the number of these findings and the patient's age, the patient can be classified into one of five prognostic groups, as defined in EBM Box 33.2. In turn, this class stratifies the patient's risk of mortality or mechanical ventilation from 1.6% to 43.8% (LRs 0.3 to 10.4; see EBM Box 33.2).

Despite its similarities to the CURB-65 score (see Chapter 32), the BAP-65 score is slightly more accurate in predicting need for mechanical ventilation in patients with COPD exacerbations than is the CURB-65 score.[30]

*The references for this chapter can be found on www.expertconsult.com.*

[†] *BAP* is an acronym for *B*lood urea nitrogen, *A*ltered mental status, and *P*ulse.

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